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Corresponding address:
AgSAP Office
Plant Production Systems
Wageningen University
P.O. Box 430, 6700 AK Wageningen
The Netherlands
Website: www.conference-AgSAP.org
E-mail: office.PP@wur.nl

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SimKat: A virtual laboratory to explore the impact of climate change scenarios on the Western Australian wheat-belt

A. Dray, S. Asseng, P. Perez, S.P. Charles, B. Bates
RMAP/RSPAS, Coombs Building, Australian National University,
Canberra ACT 0200, Australia
Contact: anne.dray@anu.edu.au

Introduction

The impact of climate change on an entire agricultural region is often not clear (IPCC Report, 2007) due to the complex interactions between individual farmers' behaviour with the bio-physical landscape, the large range of multiple external and internal factors and the further complication of continuous changes to climate variables in time and space. As a striking example, the wheat-belt of Western Australia is one of the most vulnerable regions to climate change in Australia. Rainfall has already declined by more than 15% in the last decades and it is projected to further decline. Farm numbers are plummeting and the natural resource base is threatened by various soil degradation processes including salinity. The agricultural future of the region is highly unpredictable due to the complex and adaptive nature of human-landscape interactions. Nevertheless, policymakers relentlessly ask experts for such predictions to assist in anticipating upcoming issues and to take immediate decisions to influence future socio-economic and environmental settings of the region for the better. It is fair to recognize that, to date, scientific research has provided answers to their questions that are only partly adequate and the best available biophysical science is insufficient. It is now of critical importance to understand the long-term consequences of climate change on these already threatened social-ecological systems and to anticipate ways for local farmers to adapt.

Methods

This paper builds on a simulation model prototype that focussed on salinity changes in the wheat-belt region of Western Australia (Asseng *et al*., 2008). The model used an agent-based modelling framework and was developed with the CORMAS platform (Bousquet *et al*., 1998). It combined simplified biophysical processes of paddock cover with an extension to include CO_2 impact, dry-land salinity changes and rainfall. Simulated farmers (agents) in the model made individual land use decisions based on the performance of their past land cover productivity and market returns. In addition, farmers in the model could display various attitudes towards market signals and salinity mitigation.

In this extended version, we use the model as an exploratory tool to focus on likely climate change scenarios and their impact on the viability of an agricultural region. We explored the impact of the worst case scenario for CO_2 atmospheric concentration trend given by the IPCC Report 2007: the A1F1 storyline which corresponds to very rapid economic growth and reliance on fossil intensive energy as currently the most likely scenario (Raupach *et al*., 2007). Additionally, we overlap climate change trend impacting upon maximum yield grain with technological trends influencing farmers' ability to crop (Ewert *et al*., 2005). As input data for rainfall, we use 50 generated rainfall series covering the 2001–2050 period. These were generated stochastically using a downscaling technique that relates changes in atmospheric predictors from a GCM (in this case the CSIRO Mk3 GCM) to multi-site daily rainfall (Charles *et al*., 1999). The stochastic nature of the generated series accounts for the variability in the timing of daily rainfall sequences resulting from natural climate variability and long-term climate change.

Results and discussion

Simulated scenarios will be discussed related to the impact of rainfall variability, drought sequences and atmospheric CO_2 increase on individual and regional farm viability (farm survival and size) and environmental sustainability (i.e. salinity extension). The scenarios will provide means to closely analyse the resilience of a region to potential impacts of climate uncertainty (based on ensemble data) and prolonged period of extreme dry periods on an agricultural region. The model does not aim at predicting but rather delineating the range of possible outcomes resulting from coupling climate change rainfall scenarios with likely CO_2 and technology trends.

We aim to expend the potentialities of this model into an interactive modelling tool of climate change consequences at a much deeper level to inform future agricultural policies. An iterative and participatory process with policymakers and relevant stakeholders will allow for discussion on available sustainable land use options or conditions of social and economic resilience of farming communities. This approach is seen as a first step towards participative citizenship mediated by computer-assisted tools in order to build mutual understanding, trust and respect amongst stakeholders and to secure effective decisions at different levels of implementation. In the context of the Western Australian wheat-belt, this approach might be the only way to anticipate the potential success or failure of policy interventions in relation to climate change impact and adaptation and therefore contribute to safeguarding the social, ecological and economic fabric of the region.

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